# Drought timing impacts on chlorophyll content and photosynthesis in New England trees

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Drought is a major driver of recent forest mortality (Allen et al., 2015). Despite predictions for increased annual precipitation in New England, the expected increase in temperatures as well as the high variability in the timing and amount of rainfall in individual events is expected to lead to more extreme droughts in the region (Vose et al., 2019). Importantly, most native trees are not well adapted to drought. Therefore, even moderate future droughts are expected to surpass the physiological thresholds of native trees in New England (Liénard et al., 2016). Indeed, a recent moderate drought in Massachusetts pushed some New England trees to the point of hydraulic failure in their vascular systems (Wason et al., 2018) despite little or no visible change in forest health or structure. As climate continues to change, future conditions are expected to be beyond what our native plants have experienced in the recent past (Figure 1). Therefore, to better predict and prepare for future ecosystem change, we critically need experimental manipulations of climate conditions to approximate the range of future possible climate conditions that native plants will experience.

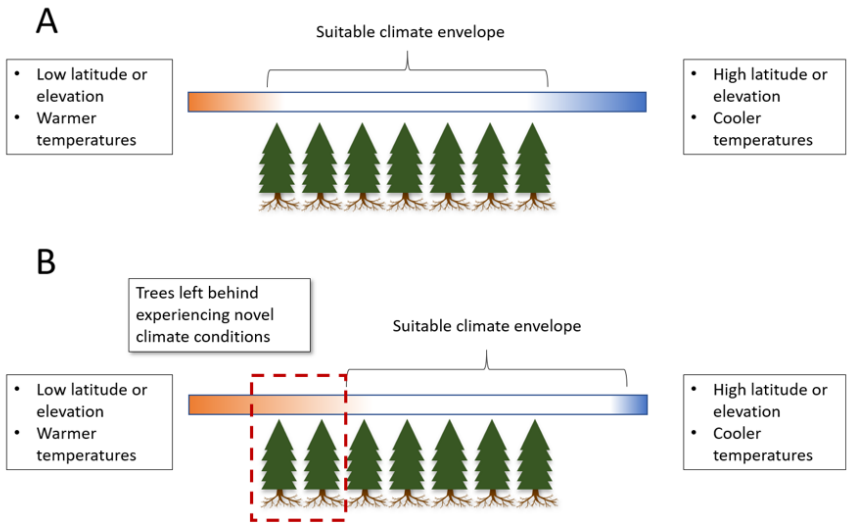


Figure 1. Schematic diagram showing (A) a population of trees within their suitable climate envelope along a latitudinal or elevational gradient. (B) After climate warming, the suitable climate envelope shifts northward or to higher elevations leaving the trees at the trailing range margin experiencing novel climate conditions (red dashed box).

The *long-term goal of my research program* is to identify the physiological climate change thresholds of trees in New England to better inform conservation and management decisions. The overall objective of the research in this proposal is to address these long-term goals by starting with saplings – a sensitive size class that can inform the expansion of my research program to other life stages. The *central hypothesis* of this research is that many New England forest trees already suffer physiological declines from short term drought (D'Orangeville et al., 2018; Peters et al., 2015; Wason et al., 2018) and will experience larger declines in photosynthesis, growth, and vigor when subjected to more intense physiological droughts that are likely in the future (Vose et al., 2019). Determining the impact of droughts on physiological and morphological change in New England trees, will improve predictions of the long-term consequences of climate change on forest ecosystems. This research will form the framework for my first master's student project and will continue my ongoing research at the University of Maine connecting fine scale physiological and anatomical responses to larger scale implications of global environmental change.

The *overall goal* of this research project is to determine **how seasonal timing and severity of drought drives long-lasting physiological declines in trees native to New England.** To accomplish this goal, we will impose experimental drought on 288 saplings of six tree species native to New England (Table 1) with varying levels of anticipated drought tolerance and expectations for future survival and growth in New England based on large-scale modeling studies (Janowiak et al., 2018; Peters et al., 2015). The seasonal timing of drought has been shown to negatively impact tree growth (D'Orangeville et al., 2018). However, the physiology behind why droughts during different times of year have different effects is unclear. Therefore, in this experiment, droughts will be imposed during important periods of tree development and growth: during early spring, early summer, and late summer. Twice per week we will measure a suite of physiological and anatomical variables to detect the threshold for major declines in tree water potential, stomatal conductance, growth, and survival of each species and how the timing of drought impacts long-term responses.

**Table 1**. Species list for sapling drought experiment with estimates of drought resistance (Peters et al., 2015) and expected future change in abundance in New England (Janowiak et al., 2018).

| Common name | Scientific name | Drought resistance | Future expectation for New England |
|---|---|---|---|
| Paper birch | *Betula papyrifera* | Low | Decline |
| Red maple | *Acer rubrum* | Moderate | Stable |
| Black cherry | *Prunus serotina* | High | Increase |
| Northern white cedar | *Thuja occidentalis* | Low | Decline |
| Eastern white pine | *Pinus strobus* | Moderate | Stable |
| Eastern red cedar | *Juniperus virginiana* | High | Increase |

**The objective of this proposal is to expand this project to quantify how drought timing impacts chlorophyll content and photosynthetic performance of trees of New England.** Chlorophyll is a critical component of the photosynthetic process and the ability of plants to produce chlorophyll is limited by environmental stressors including drought. Therefore, in this proposal we are seeking funding for instruments to measure chlorophyll content (Quero et al., 2006) and photosynthetic performance (Guadagno et al., 2017) on the saplings experiencing drought. These measurements will fill a critical gap in our research by allowing us to identify if chlorophyll production and performance is the link between the environmental stressor (drought stress) and reductions in growth and vigor of saplings. Furthermore, due to the non-destructive nature of these measurements, we will be able to conduct repeated measurements throughout the course of the drought and recovery period. This work is critical to improving our understanding of how trees of New England will respond to novel future climate conditions and is an important step advancing how we measure, study, and monitor species responses to global changes. Because we are expecting novel climate conditions, we can no longer rely on past plant responses to the environment and must use experiments to push native plants beyond their current suitable climate envelopes (Figure 1) and use physiology to quantify the response.

Figure 2. High-tunnel greenhouse construction, from top left and clockwise; construction of the greenhouse, undergraduate technician filling containers with soil, 288 saplings just after being planted in spring 2019, and the saplings in August 2019. Drought treatments will be initiated in spring 2020.

*Research plan* - To accomplish this objective, we have established a drought experiment (DroughtTIME: Drought Timing Impacts in Maine) at the University of Maine, Orono campus using six tree species native to the eastern United States (Table 1). The trees were selected to include both gymnosperms and angiosperms and represent a range of drought tolerances and expected future distributions in New England. The experiment was designed with a statistical consultant from the University of Maine and with guidance from the manager of the University greenhouses and nursery. The DroughtTIME experiment is being conducted within a custom 20'×36' high-tunnel greenhouse to provide complete control over rainfall and avoid challenges from variable natural precipitation (Hoover et al., 2018). The greenhouse was constructed in spring 2019. The sides of the greenhouse are open to facilitate air-flow and limit warming. Within the greenhouse, twelve experimental blocks were constructed consisting of 24 saplings each (Figure 2). Each block contains four 1-2' tall saplings from each of the six species. Each sapling was randomly assigned to a location within a block and was planted in a 1' diameter container with nursery soil mix. Each of the four saplings from each species was assigned to a different watering treatment using independent irrigation lines. The four treatments are: control (irrigation all summer), spring drought (initiated at budburst), early summer drought (initiated June 15), and late summer drought (initiated August 1).

**To quantify how drought timing impacts chlorophyll content and photosynthetic performance in trees of New England,** we will monitor chlorophyll content (CCM-200plus) and photosynthetic efficiency (PAR-FluorPen FP 110/D) twice per week for the duration of the experiment (Guadagno et al., 2017; Silim et al., 2009). For each species we will also quantify drought stress by measuring soil water content using a soil moisture probe and predawn water potential using a Scholander style pressure chamber. We will also monitor growth phenology, height and diameter growth, and survival on all individuals. With these data we will determine the level of drought that drives declines in plant water potential and relate those directly to the chlorophyll content of the leaves and their photosynthetic performance.

**Literature cited**


Allen, C. D., Breshears, D. D., & McDowell, N. G. (2015). On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene. *Ecosphere*, *6*(8), art129.

D'Orangeville, L., Maxwell, J., Kneeshaw, D., Pederson, N., Duchesne, L., Logan, T., Houle, D., Arseneault, D., Beier, C. M., Bishop, D. A., Druckenbrod, D., Fraver, S., Girard, F., Halman, J., Hansen, C., Hart, J. L., Hartmann, H., Kaye, M., Leblanc, D., … Phillips, R. P. (2018). Drought timing and local climate determine the sensitivity of eastern temperate forests to drought. *Global Change Biology*, *24*(6), 2339–2351. https://doi.org/10.1111/gcb.14096

Guadagno, C. R., Ewers, B. E., Speckman, H. N., Aston, T. L., Huhn, B. J., DeVore, S. B., Ladwig, J. T., Strawn, R. N., & Weinig, C. (2017). Dead or Alive? Using Membrane Failure and Chlorophyll a Fluorescence to Predict Plant Mortality from Drought1[OPEN]. *Plant Physiology*, *175*(1), 223–234. https://doi.org/10.1104/pp.16.00581

Hoover, D. L., Wilcox, K. R., & Young, K. E. (2018). Experimental droughts with rainout shelters: A methodological review. *Ecosphere*, *9*(1), n/a-n/a. https://doi.org/10.1002/ecs2.2088

Janowiak, M. K., D'Amato, A. W., Swanston, C. W., Iverson, L., Thompson, F. R., Dijak, W. D., Matthews, S., Peters, M. P., Prasad, A., Fraser, J. S., Brandt, L. A., Butler-Leopold, P., Handler, S. D., Shannon, P. D., Burbank, D., Campbell, J., Cogbill, C., Duveneck, M. J., Emery, M. R., … Templer, P. H. (2018). *New England and northern New York forest ecosystem vulnerability assessment and synthesis: A report from the New England Climate Change Response Framework project*. https://doi.org/10.2737/nrs-gtr-173

Liénard, J., Harrison, J., & Strigul, N. (2016). US forest response to projected climate-related stress: A tolerance perspective. *Global Change Biology*, n/a-n/a. https://doi.org/10.1111/gcb.13291

Peters, M. P., Iverson, L. R., & Matthews, S. N. (2015). Long-term droughtiness and drought tolerance of eastern US forests over five decades. *Forest Ecology and Management*, *345*, 56–64. https://doi.org/10.1016/j.foreco.2015.02.022

Quero, J. L., Villar, R., Marañón, T., & Zamora, R. (2006). Interactions of drought and shade effects on seedlings of four Quercus species: Physiological and structural leaf responses. *New Phytologist*, *170*(4), 819–834. https://doi.org/10.1111/j.1469-8137.2006.01713.x

Silim, S., Nash, R., Reynard, D., White, B., & Schroeder, W. (2009). Leaf gas exchange and water potential responses to drought in nine poplar (Populus spp.) clones with contrasting drought tolerance. *Trees*, *23*(5), 959–969. https://doi.org/10.1007/s00468-009-0338-8

Vose, J. M., Peterson, D. L., Luce, C. H., & Patel-Weynand, T. (2019). *Effects of drought on forests and rangelands in the United States: Translating science into management responses* (WO-GTR-98; p. WO-GTR-98). U.S. Department of Agriculture, Forest Service. https://doi.org/10.2737/WO-GTR-98

Wason, J. W., Anstreicher, K. S., Stephansky, N., Huggett, B. A., & Brodersen, C. R. (2018). Hydraulic safety margins and air-seeding thresholds in roots, trunks, branches and petioles of four northern hardwood trees. *New Phytologist*, *219*(1), 77–88. https://doi.org/10.1111/nph.15135

**Itemized budget**

| Item | Cost | Price source | Description |
|---|---|---|---|
| Chlorophyll Meter (CCM-200plus) | $1,380 | Opti-Sciences, Inc. https://www.optisci.com/ccm-200.html | Handheld device for rapid and repeat measurements of chlorophyll content |
| Fluorometer (PAR-FluorPen FP 110/D) | $3,082 | Photon Systems Instruments https://handheld.psi.cz/products/fluorpen-and-par-fluorpen/#info | Handheld device for rapid assessment of chlorophyll fluorescence |
| FluorPen Accessories | $201 | Photon Systems Instruments https://handheld.psi.cz/products/fluorpen-and-par-fluorpen/#pricing | 10 detachable leaf clips, replacement O-rings, rubber pads |
| **Total requested** | **$4,663** | | |

**Budget justification**

The total cost of the experiment is more than $25,000 of which I am requesting $4,663 from the NEBC. The total project costs include greenhouse construction, tree saplings, potting media, irrigation equipment, meteorological instrumentation, soil moisture sensors, graduate student support, and an undergraduate research technician. These costs have been (or will be) paid for with Maine Agricultural and Forest Experiment Station funds provided to Dr. Wason. In this proposal, Dr. Wason is requesting the funds for two additional instruments that will greatly improve current research: a chlorophyll meter and a fluorometer. These tools are critical for expanding our understanding of the physiology of *why* each tree species performs as it does under the drought conditions. As part of this research, an undergraduate research assistant (majoring in botany and forestry) as well as a master's student will be trained in the use of these two instruments and analysis of the data. The ease of use and ability for rapid and repeat measurements will also allow Dr. Wason to use these tools during demonstrations in his classes including SFR 102: The Structure and Function of Woody Plants Lab (~60 students per year), SFR439/539: Biology of Woody Plants (~24 students every other year), and a graduate level course on tree physiology that is currently under development. Furthermore, these two instruments will help Dr. Wason leverage additional external funding for research grants as he expands his research program.

The **Chlorophyll Meter** (CCM-200plus) is used to estimate the chlorophyll content of the leaf. The chlorophyll meter functions by measuring the amount of light energy that is absorbed at wavelengths that are related to the structure and function of chlorophyll-a. Chlorophyll content is directly related to the health and stress level of the plant and to the plants ability to photosynthesize and grow. This handheld meter is critical for repeat, nondestructive, field measurements on the trees in the DroughtTIME nursery We will be able to quantify how the timing and severity of drought impact the ability of the saplings to acquire nutrients and incorporate them into chlorophyll in leaves to improve photosynthetic performance and growth.

The **Fluorometer** (PAR-FluorPen FP 110/D) is a second critical tool that can estimate a number of parameters related to leaf function. This is an important component that will extend the implications of chlorophyll content measurements (from the Chlorophyll Meter) by quantifying how that drives photosynthetic performance. The FluorPen emits a bright light onto dark adapted leaf surfaces and accurately estimates how efficiently the leaf begins to absorb the light by measuring the excess energy that is re-emitted by the leaf as fluorescence. This is an estimate of the photosynthetic efficiency of the plant. The data will allow us to determine how efficiently and effectively the leaf is using chlorophyll for photosynthesis. Funds are also requested for accessories including leaf clips to dark-adapt multiple leaves before rapid measurements and replacement O-rings.

**Timeline**

| Research Item | Apr | May | Jun | July | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acquire instruments | X | | | | | | | | | | | |
| Train students on greenhouse plants | X | X | | | | | | | | | | |
| Conduct field measurements | | X | X | X | X | X | | | | | | |
| Data analysis | | | | | X | X | X | X | X | | | |
| Manuscript preparation | | | | | | | | X | X | X | X | X |
| Conference presentations | | | | | | | | | X | X | X | X |
| Final report to NEBC | | | | | | | | | | | | X |

**Deliverables**

There will be several deliverables from this research project. First, the master's student that will be using this experiment for part of her master's research will lead manuscript preparation for submission to a peer-reviewed scientific journal. This experiment will be central to her master's thesis. She will also present her research at a regional conference such as the Forest Ecosystem Monitoring Cooperative's Annual Conference in Vermont (December 2020) or the Annual American Society of Plant Biologists Northeast Section meeting (Spring 2021). This research project will also supplement a current undergraduate students research project relating leaf and wood hydraulics in native trees. Finally, this work will be the cornerstone of additional research in my lab as the DroughtTIME experiment runs for a second year to capture legacy effects of drought leading to further manuscripts and presentations beyond the timeline of this proposal. Dr. Wason also leads an average of 4-6 public outreach talks per year on climate change impacts on native forests of New England and will integrate the data generated from this project into his presentations.

# Jay Wason
# Curriculum vitae

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## PROFESSIONAL APPOINTMENTS

2018 - present **Assistant Professor of Forest Ecosystem Physiology**, University of Maine, School of Forest Resources.

2016 - 2018 **Postdoctoral Research Associate**, Yale School of Forestry & Environmental Studies.

## EDUCATION

2016 **Ph.D. Ecology,** SUNY College of Environmental Science and Forestry (ESF).

2011 **B.A. Environmental Studies**, University of Pittsburgh.

2011 **Certificate Geographical Information Systems**, University of Pittsburgh.

## PUBLICATIONS

(* denotes undergraduate mentee)

### Peer reviewed

2019 **Wason J**, Beier C, Battles J, and Dovciak M. Acidic deposition and climate warming as drivers of tree growth in high-elevation spruce-fir forests of the Northeastern US. *Frontiers in Forests and Global Change*, 2. doi: 10.3389/ffgc.2019.00063

2019 **Wason J**, Brodersen C., and Huggett B. The functional implications of tracheary connections across growth rings in four northern hardwood trees. *Annals of Botany.* 124(2). doi: 10.1093/aob/mcz076

2019 Brodersen C, Roddy A, **Wason J**, and McElrone A. Functional status of xylem through time. *Annual Review of Plant Biology.* 70. doi: 10.1146/annurev-arplant-050718-100455

2018 Berdugo Moreno MB, Quant, J, **Wason J**, and Dovciak M. Latitudinal patterns and environmental drivers of moss layer cover in extratropical forests. *Global Ecology and Biogeography*. 27(10), 1213-1224. doi: 10.1111/geb.12778

2018 **Wason J**, Anstreicher K*, Stephansky N*, Huggett B, and Brodersen C. Hydraulic safety margins and air-seeding thresholds in roots, trunks, branches, and petioles of four northern hardwood trees. *New Phytologist*, 219(1), 77-88. doi: 10.1111/nph.15135.

2017 **Wason J**, Huggett B, and Brodersen C. MicroCT imaging as a tool to study vessel endings *in situ*. *American Journal of Botany*, 104(9), 1424-1430. doi: 10.3732/ajb.1700199.

2017 **Wason J**, Bevilacqua E, and Dovciak M. Climates on the move: Implications of climate warming for species distributions in mountains of the northeastern United States. *Agricultural and Forest Meteorology*, 246, 272-280. doi: 10.1016/j.agrformet.2017.05.019.

2017 **Wason J**, Dovciak M, Beier C, and Battles J. Tree-growth is more sensitive than species distributions to recent changes in climate and acidic deposition in the northeastern United States. *Journal of Applied Ecology*, 54, 1648–1657. doi: 10.1111/1365-2664.12899.

2017 **Wason J** and Dovciak M. Tree demography suggests multiple directions and drivers for species range shifts in mountains of northeastern United States. *Global Change Biology*, 23, 3335–3347. doi: 10.1111/gcb.13584.

**Technical Reports**

2016 Dovciak M, Friar J, Lesser M, **Wason J,** and Roberts M. Evaluating deer impacts on forests of New York State. Final Report for New York State Department of Environmental Conservation.

2013 **Wason J**. Climate change impacts in high-elevation northeastern boreal forest plant communities. Final Report for Edna Bailey Sussman Award.

2010 **Wason J**. Riverine forest dynamics and informing Thresholds of Potential Concern along the Sabie River, Kruger National Park. Final Report for Research Internship.

## SEMINARS AND PRESENTATIONS

(* denotes undergraduate mentee)

2019 **Wason J**. "Using three-dimensional wood anatomy to understand tree responses to climate change". Invited seminar. Department of Biology, University of Sherbrooke. Sherbrooke, QC (December).

2019 **Wason J**. "Climate change impacts in forest ecosystems". Invited public seminar. Moosehead Historical Society & Museums. Greenville, ME (August).

2019 **Wason J**. "Current state of knowledge and research on potential effects of climate change on forest ecology". Presenter and panelist in session on UMaine's Forest Climate Change Initiative: An Overview and Discussion. Maine Sustainability & Water Conference. Augusta, ME (March).

2019 **Wason J**. "Climate change impacts in forest ecosystems". Invited public seminar. Southern Aroostook County Soil & Water Conservation District Winter Ag School. Littleton, ME (March).

2018 **Wason J**. "Climate change impacts in forest ecosystems". Invited public seminar. Piscataquis County Soil & Water Conservation District. Greenville, ME (November).

2018 **Wason J**. "3D wood anatomy and microCT". Guest lecture in Plant Physiology, University of Maine School of Biology and Ecology (October).

2018 Brodersen C, **Wason J**, and Huggett B. "Three-dimensional xylem organization and its implications for water transport during drought". Oral presentation at Botany 2018 (July).

2018 Huggett B, **Wason J**, and Brodersen C. "The functional implications of the presence or absence of intervessel connections across growth rings of four northern hardwood trees". Poster presentation at Botany 2018 (July).

2018 **Wason J**, Huggett B, and Brodersen C. "Using 3D data and virtual reality to teach xylem anatomy". Poster and interactive display at the Multiscale Plant Vascular Biology Gordon Research Conference and Seminar (June).

2018 Huggett B, **Wason J**, and Brodersen C. "The functional implications of the presence or absence of intervessel connections across growth rings of four northern hardwood trees". Poster presentation at the Multiscale Plant Vascular Biology Gordon Research Conference (June).

2018 Brodersen C, **Wason J**, and Huggett B. "Modeling xylem network performance and vulnerability curves with microCT-derived connectivity parameters". Poster presentation at the Multiscale Plant Vascular Biology Gordon Research Conference (June).

2018 Brodersen C and **Wason J**. "3D printed plants". Presentation for the Green Café Yale University (May).

2018 **Wason J**. "Forests on the move: Spruce-fir and northern hardwood tree responses to environmental change". Invited seminar, SUNY Plattsburgh (April).

2018 **Wason J**. "3D wood anatomy". Guest lecture in Dendrology, SUNY Plattsburgh (April).

2018 **Wason J**. "Principles of dendrochronology". Guest lecture in Wood: Structure and Function, Yale School of Forestry & Environmental Studies (September).

2018 **Wason J**, Huggett B, and Brodersen C. "Intervessel connections across growth rings in xylem of northern hardwood trees". Poster presentation at the Harvard Forest Ecology Symposium (March).

2018 **Wason J** and Brodersen C. "Three-dimensional teaching: Using virtual reality and 3D printed models in the classroom". CIRTL Leaders Meeting Showcase at the Center for Teaching and Learning, Yale University (March).

2018 Brodersen C and **Wason J**. "Using 3D prints in teaching, research, and outreach". Invited Seminar and interactive session at the Center for Teaching and Learning, Yale University (February).

2018 **Wason J**. "Structure and function of tree xylem networks in response to drought". Invited Seminar at Harvard Forest (February).

2017 **Wason J**, Huggett B, and Brodersen C. "Xylem-vessel networks and drought resistance in northern hardwood trees". Poster presentation at the Forest Ecosystem Monitoring Cooperative's Annual Conference (December).

2017 **Wason J**, Huggett B, and Brodersen C. "Teaching in the third dimension: using 3D printed models and virtual reality to teach plant xylem anatomy". Poster presentation at the Southern Connecticut State University Scientific Teaching Forum (September).

2017 **Wason J**. "Plant hydraulics and wood anatomy". Guest lecture in Plant Ecophysiology, Yale School of Forestry & Environmental Studies (September).

2017 **Wason J**. "Plant anatomy in virtual reality". Guest lecture in Plant Ecophysiology, Yale School of Forestry & Environmental Studies (September).

2017 **Wason J**, Anstreicher K*, Stephansky N*, Huggett B, and Brodersen C. "Hydraulic safety margins in roots, trunks, branches, and petioles of northern

hardwood trees". Oral presentation at the Ecological Society of America's Annual Meeting (August).

2017 **Wason J** "Northeastern forest health in the Anthropocene: What are you trying to prove?". Invited Seminar at Bates College (May).

2017 **Wason J**, Anstreicher K*, Stephansky N*, Huggett B, and Brodersen C. "Hydraulic safety margins in roots, trunks, branches and petioles of northern hardwood trees". Poster presentation at the Northeast Regional American Society of Plant Biologists Conference (April).

2017 **Wason J**, Anstreicher K*, Stephansky N*, Huggett B, and Brodersen C. "New England Forests and the 2016 Drought: Hydraulic safety margins and physiological tipping points of four hardwood tree species". Poster presentation at the 33rd Annual Yale School of Forestry & Environmental Studies Research Conference (April).

2017 **Wason J**, Anstreicher K*, Stephansky N*, Huggett B, and Brodersen C. "Hydraulic safety margins in roots, trunks, branches and petioles of northern hardwood trees". Poster presentation at the Harvard Forest Ecology Symposium (March).

2016 Stephansky N*, Anstreicher K*, **Wason J**, Brodersen C, and Huggett B. "The resistance to drought in two dominant New England hardwood species". Poster presentation at the Research Experiences for Undergraduates Symposium, Council on Undergraduate Research (October).

2016 Dovciak M, **Wason J**, Lesser M, Hurst J, and Frair J. "Ecological drivers of native and non-native forest plant species diversity and composition in New York State". Oral presentation at the Ecological Society of America's Annual Meeting (August).

2015 **Wason J**, Dovciak M, and Bevilacqua E. "Mountain Climates on the Move: Implications for Past and Future Vegetation Shifts in the Northeastern United States". Oral presentation at the American Geophysical Union's Annual Fall Meeting (December).

2015 **Wason J** and Dovciak M. "Demographic responses of tree communities relative to recent environmental change in northeastern mountain forests". Oral presentation at the Ecological Society of America's Annual Meeting (August).

2015 **Wason J**. "The deliberation of the Ents: Tree community response lags recent environmental change in northeastern mountain forests." Invited Seminar at Utica College (March).

2015 **Wason J**. "A walk in the woods: Plant communities of northeastern mountain forests". Invited Seminar at the Syracuse Botanical Club (March).

2015 **Wason J** and Dovciak M. "Evidence of elevational shifts in northeastern U.S. forest tree populations". Oral presentation at the New York Society of American Foresters Annual Meeting (January).

2015 **Wason J** and Dovciak M. "Elevational distributions of tree species: Climate, land management history, or soils?" Poster presentation at the New York Society of American Foresters Annual Meeting (January).

2014 **Wason J**, Dovciak M, Beier C, and Battles J. "Responses of tree populations to recent climatic trends in northeastern mountain forests: Thinking beyond range margins". Poster presentation at the Ecological Society of America's Annual Meeting (August).

2014 **Wason J**, Dovciak M, Beier C, and Battles J. "Responses of tree populations to recent climatic trends in northeastern mountain forests: Thinking beyond range margins". Poster presentation at the ESF Spotlight on Student Research and Outreach (April).

2013 Busman A*, **Wason J**, and Dovciak M. "Recent convergence of red spruce (*Picea rubens*) growth rates at high and low elevations on Whiteface Mtn., New York". Poster presentation at the Adirondack Research Consortium 20th Annual Conference (May).

2010 **Wason J**, Kruger L, and Grant R. "Riverine forest dynamics and informing Thresholds of Potential Concern along the Sabie River, Kruger National Park". Oral presentation at the South African National Parks Meeting on Elephant Impacts in Kruger National Park (July).

## MENTORING

### Graduate advisor

Kelly French. MS. University of Maine, School of Forest Resources. Current.

Ruth van Kampen. MS. University of Maine, School of Forest Resources. Current.

### Committee member

Rafa Tasnim. Ph.D. Committee (advisor: J. Zhang). University of Maine, School of Biology and Ecology. Current.

Arin Chen. MS Committee (advisor: J. Zhang). University of Maine, School of Biology and Ecology. Current.

Pratima Pahadi. MS Committee (advisor: J. Zhang). University of Maine, School of Biology and Ecology. Current.

Jeanette Allogio. MS Committee (advisor: S. Fraver). University of Maine, School of Forest Resources. Current.

Jordon Tourville. Ph.D. Committee (advisor: M. Dovciak). SUNY College of Environmental Science and Forestry. Current.

**Undergraduate research advisor**

Aashish Dhungana. Undergraduate research technician. University of Maine, School of Forest Resources. Current.

Maddie Eberly. Undergraduate laboratory technician. University of Maine, School of Forest Resources. Current.

Chantal Bussiere. Honors thesis committee member. University of Maine, Ecology and Environmental Sciences. Current.

Ruth van Kampen. Harvard Forest Research Experience for Undergraduates. 2018.

Katja Diaz-Granados. Harvard Forest Research Experience for Undergraduates. 2018.

Paul Jacquot, Yale undergraduate in Introduction to Archaeology Laboratory Sciences. "Identifying wood from an archaeological site in the American Southwest". 2016.

Katherine Anstreicher, Yale University. Harvard Forest Research Experience for Undergraduates. "Characterizing drought resistance of New England saplings by species and tissue type". 2016.

Nathan Stephansky, Bates College. Harvard Forest Research Experience for Undergraduates. "Vulnerability to cavitation in xylem across and within growth rings in four hardwood species". 2016.

Adam Busman, SUNY ESF. NSF-UMEB Scholar and Undergraduate Intern. "Forest dynamics and growth-rates of red spruce along elevation gradients on Whiteface Mountain relative to regional climate change". 2012 – 2013.

**Other mentoring experience**

Ecological Society of America SEEDs Meeting Mentor. 2018.

## TEACHING AND PROFESSIONAL DEVELOPMENT

2018 Cooperative Forestry Research Unit, Fall Field Tour: Outcome Based Forestry and Long-Term Research (1 day).

2018 Certificate of College Teaching Preparation, Center for Teaching and Learning, Yale University.

2017 Theory and Practice of Scientific Teaching Course, Center for Teaching and Learning, Yale University (24 hours).

2017 Ouch! That Stereotype Hurts, Diversity Workshop, Yale University (2 hours).

2016 Scientific Writing Course, Yale University (16 hours).

2016 Writing and Designing NSF Proposals Workshop, Columbia University (8 hours).

2015 Teaching Fellow, Graduate Assistant Colloquium on Teaching and Learning, SUNY ESF.

2015 Embedding Research in Undergraduate Classes across the Geoscience Curriculum Workshop, American Geophysical Union Fall Meeting (2.5 hours).

2015 Beginner Blackboard Seminar, SUNY ESF (1 hour).

2011 Annual Colloquium on Teaching and Learning, SUNY ESF (2 days).

## COURSES TAUGHT

Introduction to Forest Biology. 2019 and 2020. SFR100. University of Maine School of Forest Resources.

Structure and Function of Wood Plants Laboratory. 2019 and 2020. SFR102. University of Maine School of Forest Resources.

Research Methods in Forest Resources. 2018 and 2019. SFR521. University of Maine School of Forest Resources.

Plant Ecology, Statistics, Mapping and Orienteering, and co-leader of Student Research Projects. Summer 2014 and 2015. Ecological Monitoring and Biodiversity Assessment, Cranberry Lake Biological Station, SUNY ESF.

Teaching Assistant for Plant Ecology and Global Change (2015), Organismal Biology and Ecology Laboratory (2014), and Dendrology (2011). SUNY ESF.

## PROFESSIONAL SERVICE AND OUTREACH

Forest Climate Change Initiative member. University of Maine, Center for Research on Sustainable Forests. 2019.

Committee member of the Allen International Travel Fund. University of Maine, School of Forest Resources. 2019

Organizer for "Experience a Mini Scientific Conference at the Yale School of Forestry & Environmental Studies" high-school outreach event, Yale University. April 2018.

Pathways to Science coordinator and planning committee member for Yale School of Forestry & Environmental Studies Annual Research Day Conference, Yale University, December 2017 – April 2018.

3D printed models for teaching plant anatomy, Yale University. 2016 – present. Produced a series of 3D models and information sheets for teaching plant anatomy that are part of a free online data portal (linked from my webpage).

Graduate Student Representative on Faculty Search Committee, SUNY ESF Department of Environmental and Forest Biology, December 2015 – April 2016.

Department Representative and Coordinator of Graduate Student Travel Grants, SUNY ESF Graduate Student Association, April 2014 – April 2015.

Graduate student mentor, Ecological Society of America's Plant Population Ecology Section, September 2015 – present.

**Reviewer** for *Annals of Botany*, *AOB Plants*, *Applied Vegetation Science*, *Biodiversity and Conservation*, *Environments*, *Diversity and Distributions*, *Ecology*, *Forest Science*, *Forests*, *Global Change Biology*, *International Journal of Climatology*, *Journal of Vegetation Science*, *Northeastern Naturalist*, *Plant Ecology*, *Plant Physiology*, *PLOS ONE*, *Restoration Ecology*

Invited Grant Review Committee Member, SUNY ESF Graduate Student Association Research Grants, Fall 2013 and Spring 2014.

Invited panelist, Core Course for Graduate Students, SUNY ESF. October 2013 and September 2015.

Onondaga Lake Bioblitz, SUNY ESF. 2014. Identified plants and mentored undergraduate students as part of 24-hour biodiversity assessment of Onondaga Lake.

Judge, Environmental Challenge 2013, 7$^{th}$ and 8$^{th}$ Grade Science Fair, Syracuse University. Syracuse, NY.

## GRANT PROPOSALS FUNDED

"Feedbacks between wood structure and function driving forest tree responses to extreme drought" Eberly M (undergraduate lab member, Dr. Wason as advisor). University of Maine Center for Undergraduate Research Fellowships program $1,100.

“Requirements for Successful Recruitment of Northern White-Cedar in Lowland Stands in Maine.” Penobscot Experimental Forest Research Operations Team. March 2019. PI: Shawn Fraver. Co-PIs: Laura Kenefic, Jay Wason, Pascal Berrill, Jeanette Allogio. $4,700.

“3D Glasses and X-Ray Vision: New Tools for Integrating Teaching and Research in the Classroom”. Rosenkranz Fund for Pedagogical Advancement, Yale University. May 2018 – May 2019. Co-PI with Craig Brodersen. $9,020.

“Climate change impacts in high-elevation northeastern boreal forest plant communities”. Edna Bailey Sussman Foundation. May – August 2013. $6,370.

## OTHER AWARDS AND HONORS

2017 Popular Vote Winner, Advanced Light Source Science as Art competition.
2017 Best Poster Award, 33rd Yale School of Forestry & Environmental Studies Research Conference.
2015 Plant Population Ecology Student Travel Award. $200.
2015 SUNY ESF Graduate Student Association Travel Grant. $250.
2015 Josiah L. Lowe-Hugh Wilcox Graduate Scholarship. $1,505.
2014 Ecological Society of America, Real Brown Travel Award. $300.
2014 SUNY ESF Graduate Student Association Travel Grant. $250.
2014 SUNY ESF Graduate Student Travel Grant. $400.
2013 Randolph G. Pack Environmental Institute Travel Grant. $250.
2012 Edwin H. Ketchledge Scholarship. $800.

## PROFESSIONAL ASSOCIATIONS

American Society of Plant Biologists
Ecological Society of America
American Geophysical Union